

Spaceflight Meteorology Group’s Frank Brody answers questions about hurricanes

How is a hurricane formed?

Hurricanes originate as a cluster of showers and thunderstorms in tropical waters. Three major factors are required for hurricane formation—warm ocean water, favorable low level winds and light upper level winds.

A hurricane’s main sources of energy are heat and moisture. Developing hurricanes gather these sources through contact with warm ocean waters. Typically, water temperatures of 80 degrees Fahrenheit or warmer are needed storm development.

Wind patterns are critical for tropical storm formation. The pattern most conducive to tropical storm formation is when low level winds, below 5,000 feet, are converging, and upper level winds, above 25,000 feet, are light and diverging. Upper level winds that are too strong will greatly inhibit tropical storm development, and often cause a hurricane or tropical storm to weaken.

What are the different parts of the hurricane?

The typical hurricane has two or three and sometimes more outer convective bands, also called “feeder bands.” These bands are comprised of cells resembling ordinary thunderstorms and can be up to 300 miles from the eye. The outer convective bands are generally 40 to 80 miles apart and come in advance of the main rain shield.

The rain shield is a solid area of rain that typically becomes heavier closer to the eye. The outer edge is well defined and its distance from the eye varies greatly from storm to storm.

Spiral bands or convective rings are regions of active showers and thunderstorms that encircle the centers of hurricanes. They are especially prevalent in the more intense hurricanes and curve cyclonically inward toward the center of the storm where they appear to merge to form the eye wall.

The eye wall is an organized band of thunderstorms that immediately surrounds the center or eye of a hurricane. It’s generally around 15 miles wide and typically contains the fiercest winds and most intense rainfall.

The eye is a relatively calm center of the hurricane. The winds are light, and skies may be partly cloudy or even clear. The average hurricane eye diameter is a little more than 20 miles.

In general, when the eye is shrinking in size, the hurricane is intensifying. After the eye’s passage, the violent wind blows in the opposite direction to what it was right before the eye moved over an area and the heavy rain returns.

What is a storm surge?

A storm surge is a large dome of water often 50 to 100 miles wide that sweeps across the coastline near where a hurricane makes landfall. Storm surge can range from four to six feet for a minimal hurricane to greater than 20 feet for the stronger ones. The stronger the hurricane and the shallower the offshore water, the higher the surge will be. This can cause severe flooding in coastal areas, especially when the storm surge coincides with normal high tides. Water weighs about 1,700 pounds per cubic yard; extended pounding by frequent waves can demolish any structures not specifically designed to withstand such forces. Along the immediate coast, storm surge is the greater threat to life and property, even more so than the high winds.

More than 8,000 people were killed in the Galveston hurricane of 1900, most by storm surge. Hurricane Camille produced a 25-foot storm surge in Mississippi. Hurricane Hugo in 1989 generated a 20-foot storm tide in South Carolina. Hurricane Andrew in 1992 caused a 17-foot storm surge in southeast Florida.

Note, the elevation of JSC ranges from 15 to 23 feet, so a 20 foot storm surge could put the lowest elevations at JSC under five feet of water.

How much rainfall and flooding can a hurricane produce?

Hurricanes, tropical storms and tropical depressions are capable of producing abundant amounts of flood-producing rainfall. During landfall, a hurricane rainfall of six to 12 inches is common. If the storm is large and moving slowly, greater amounts of rainfall can be expected. To get a rough estimate of the potential rainfall amount (in inches), divide the storm’s forward motion into 100. For example, a storm moving five miles per hour could produce 20 inches of rain.

Tropical Storm Claudette in 1979 brought 45 inches of rain to an area near Alvin, Texas, contributing to more than \$600 million in damage. Hurricane Agnes rainfall in 1972 caused disastrous floods in the eastern U.S, including 118 deaths and \$2.1 billion in property damage.

What about tornadoes?

Hurricanes also produce tornadoes, which add to the hurricane’s destructive power. Typically, the more intense a hurricane is, the greater the tornado threat. When a hurricane brings its winds inland, the fast-moving air hits terrain and structures, causing increased low level wind convergence due to friction. This, in turn, enhances atmospheric lifting which increases the threat of tornadoes. The greatest concentration of tornadoes occurs in the right front quadrant of the hurricane.

What kind of damage can happen from the wind of a hurricane?

Hurricane winds are a serious force to be reckoned with. As winds increase, pressure against objects is added at a disproportionate rate. Pressure force against a wall increases with the square of wind speed; a threefold increase in windspeed gives a ninefold increase in pressure. A 25 mph wind causes about 1.6 pounds of pressure per square foot, and places 50 pounds of force on a four by eight sheet of plywood. In 75 mph winds, that force becomes 450 pounds, and in 125 mph, it becomes 1,250 pounds.

Who issues hurricane watches and warnings?

Hurricane watches, warnings and advisories are officially issued by the National Weather Service’s National Hurricane Center in Coral Gables, Fla. Meteorologists at this center specialize in hurricane and tropical storm forecasting. They continually monitor atmospheric and ocean conditions, evaluate an array of atmospheric computer models and disseminate watches, warnings and advisories on all stages of tropical systems, including tropical depressions, tropical storms and hurricanes. The Houston/Galveston National Weather Service Office in League City, Texas customizes hurricane watches and warnings for southeast Texas. The Spaceflight Meteorology Group customizes watches, warnings and advisories for JSC management and emergency planning managers.

How accurate are hurricane forecasts?

The National Weather Service’s National Hurricane Center in Miami, Fla., prepares the

official hurricane watches, warnings and advisories for the U. S. and adjacent ocean areas. Hurricane forecasters use their expertise about these storms, along with a suite of atmospheric numerical models, to forecast motion and intensity, leading to issuances of watches and warnings for land areas. Major advances have been made in hurricane forecast accuracy during the past 25 years due to improved satellite imagery and more sophisticated computer models. The average 72-hour forecast position error is about 300 miles, and the average 24 hour forecast position error is about 100 miles. This distance can mean the difference between destructive winds and storm surges and merely “tropical storm” conditions. Hurricane forecasting is improving but is not an exact science. Hurricane intensity changes are quite difficult to predict and the best plan is to expect the worst. A good rule of thumb is to plan for a storm arriving one category stronger and 12 hours sooner than predicted.

What is the difference between a tropical disturbance, tropical depression, tropical storm and a hurricane?

A tropical disturbance is a discrete system of organized showers and thunderstorms that originates in the tropics and maintains its identity for 24 hours or more.

A tropical depression is an organized system of clouds and thunderstorms with a defined counter-clockwise circulation with maximum sustained winds of 38 mph or less.

A tropical storm is an organized system of strong thunderstorms with a defined circulation and maximum sustained winds of 39 to 73 mph.

A hurricane is an intense tropical weather system with a well defined circulation and maximum sustained winds of 74 mph.

A typhoon is the name given to hurricane-strength systems in the western Pacific (west of 180 degrees west longitude).

When is hurricane season?

In the Atlantic Ocean, Caribbean Sea, and Gulf of Mexico hurricane season extends from the first day in June until the last day of November. The peak hurricane threat exists from mid-August to late October. In other parts of the world, such as the western Pacific, hurricanes can occur year-round.



Know when to evacuate; planning key to protection

One of the most effective ways to protect human life during a hurricane is to evacuate and JSC Emergency Preparedness Manager Bob Gaffney encourages employees to make a plan that includes evacuation.

Gaffney, a member of the JSC Hurricane Rideout Team, encourages employees to make plans for their personal protection well in advance of the development of a hurricane.

“Now would be a good time,” he said. “Personal protection plans should anticipate the arrival of tropical storm-force winds 12 hours or more before a hurricane makes landfall, and expect more of the same on the backside of the hurricane. People who don’t evacuate in advance of a severe storm could be isolated in their homes for an extended period of time before community officials are able to restore damaged utilities and re-establish normal municipal operations,” Gaffney said.

Employees who live around JSC should take extra precautions due to the potential for flooding. Flooding can come in the form of a storm surge or heavy rainfall. Both are common occurrences associated with hurricanes.

Evacuation plans should include a specific destination, an evacuation route, (see map page 5), a list of items needed (medications, etc.) and plans for pet care.

“Make sure you have enough medication to last awhile in case your regular pharmacy is closed due to damage by a hurricane,” Gaffney said. “If pet owners are evacuating to a hotel, you need to make sure the hotel will take pets,” he added.

The evacuation route may become the most important element of an employees’ plan. To find the best possible route employees can contact their local emergency management offices (see chart on page 5). Gaffney said it’s also a good idea to have a backup route planned in case of traffic congestion or flooding. The local emergency management office also can inform employees about whether their home would be affected by storm surge and high tides.

“A lot of people forget that getting to Houston isn’t a problem during initial stages

of evacuation,” Gaffney said. “It’s the fact that beyond Houston, all escape routes are reduced to two-lane roads that can quickly become jammed despite the best efforts of traffic managers, Metro and the Texas Department of Public Safety. People have the best chance of influencing a successful evacuation if they’ll make a family emergency plan ahead of time, which includes an early evacuation decision, and stick to the plan.”

“Employees should assess the vulnerabilities of their home and contents and develop firm plans for transportation and shelter for their families,” Gaffney said. “Neither the American Red Cross nor local communities open shelters in advance of hurricane threats because Clear Lake is in a flood plain and people could get trapped in shelters when local flooding is severe.”

Hurricanes are very unpredictable, Gaffney said, and employees need to know when to activate their emergency plan. An example of how hurricanes can change without notice is Hurricane Opal in 1995. The storm was moving slowly and steadily toward Texas. It made a dramatic turn toward Florida and eventually picked up speed and increased in strength. Residents were not prepared and a last-minute evacuation turned into chaos.

The hurricane is not the only problem that can arise during the storm season. During the storm, heavy rains, tornadoes and flooding also must be considered. When making evacuation plans include alternate routes in case roads are impassable.

Gaffney said a good rule of thumb is that if a storm is in the Gulf, begin making preparations. The National Weather Service suggests planning on the hurricane being one category stronger than forecast and arriving 12 hours sooner.

“Be prepared,” Gaffney said. “Knowing what to do in an emergency, such as when a hurricane threatens, is the best possible protection you and your family can have. Check your supply list today and make sure you have everything that you will need. If you plan ahead—carefully and thoroughly—you can greatly reduce the chances of personal injury and property damage.”

JSC prepares buildings, staff to enter storm season

Spring brings one of the more pleasant seasons here on the Gulf Coast, but it also means that hurricane season is once again here.

June 1 marks the time the JSC Hurricane Rideout Team once again will keep a close eye on what is happening in the tropical waters of the Atlantic and Gulf. JSC’s Bill Roeh, chief of the Plant Engineering Division and captain of the Hurricane Rideout Team, has primary responsibility for preparing JSC when a severe storm threatens the center. He coordinates the work of area protection teams and the emergency planning representatives in every organization, and ensures that emergency supplies are ready through the Support Operations Division.

Roeh prepares the center according to preparation levels listed in the Hurricane and Sever Weather Plan.

At Action Level 4, which becomes effective when a hurricane enters the Gulf of Mexico or is within 72 hours of making landfall, the center begins to prepare. Hurricane team members review the plan once more to assure all support organizations know their part. Weather forecasters in the Spaceflight Meteorology Group provide real-time interpretations of bulletins from the National Hurricane Center and advise the Hurricane Rideout Team and JSC senior managers throughout the storm period. Recall rosters for the Hurricane Rideout Team are verified and the list of organization and contractor emergency planning representatives is checked to ensure everyone can be notified of a change in the center’s preparedness status.

Action Level 3 goes into effect if a hurricane could threaten the Clear Lake area. At the discretion of Center Operations Director Jim Hickmon, the Rideout Team relocates to the Emergency Operations Center in Bldg. 30, Rm. 3100.

Once the likelihood of a hurricane striking the Houston-Galveston area grows great enough, JSC Director George Abbey will decide whether to release employees and close the center, which usually moves the center into Action Level 2. Information concerning work assignments and closing JSC will be delivered to employees through their organization’s emergency planning

representatives.

“An important part of preparing the center for closing because of a hurricane threat is securing offices, a responsibility that falls on every employee,” said Keith McQuary JSC’s Hurricane plan manager. “Each employee should secure his or her individual work area (see to do list page 5).”

JSC’s grounds and facilities are prepared for a storm by a group of 14 Area Protection Teams from the Plant Engineering Division. They check buildings and roofs, pick up loose objects and materials outside and secure potential windblown hazards.

“The main thrust should be on preparation; those things that all employees can do to mitigate the effects of a storm or minimize the degree of damage it can do,” McQuary said. “Preparation is the key to successful recovery; we’ll recover, but our recovery will be faster if we prepare adequately in advance.”

Although emergency preparedness workers are responsible for taking care of JSC first, McQuary said, the center can help the surrounding communities on a case-by-case basis. Sharing the Emergency Operations Center as well as the center’s plans, will help community leaders know what kind of help may be available from JSC.

Level 1 starts when gale-force winds arrive at the center, making it unsafe to continue outside activities. Prior to Level 1, Roeh gathers the Rideout Team members at their posts and waits for the storm to subside. Activities during the storm are limited to essential emergency repairs that can be performed without compromising life safety or endangering personnel.

The Rideout Team goes back into action once the storm passes, assessing the damage and arranging the necessary repairs. In the event of a center closing, employees can continue to stay in contact through the use of two recorded phone services (see phone list page 5).

The Center Director is kept informed of the center’s recovery status by the Center Operations Director. Public Affairs notifies employees when to return to work through the information services and return-to-work notifications broadcast by local radio and television stations.